Wire chamber update

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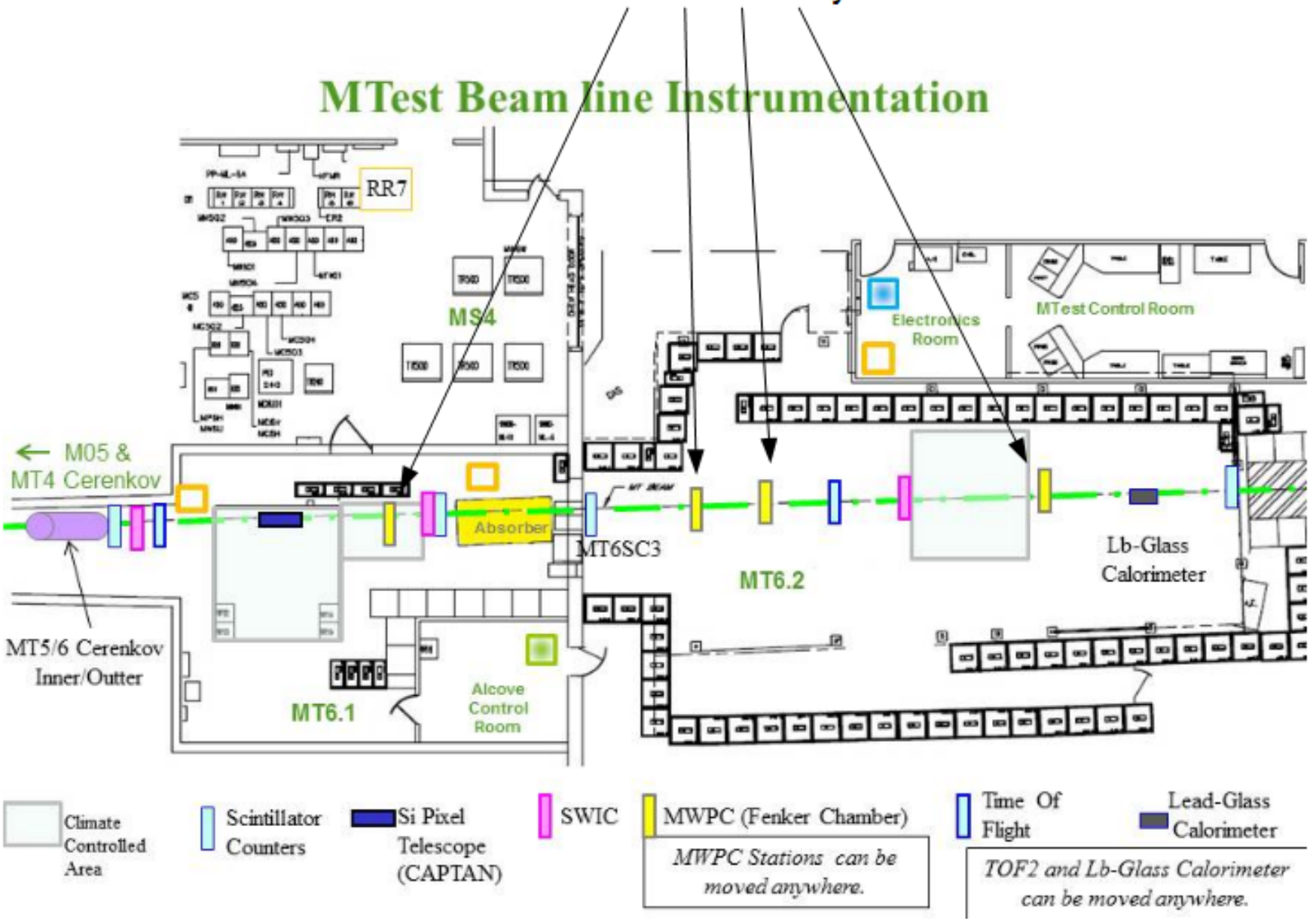
Outline

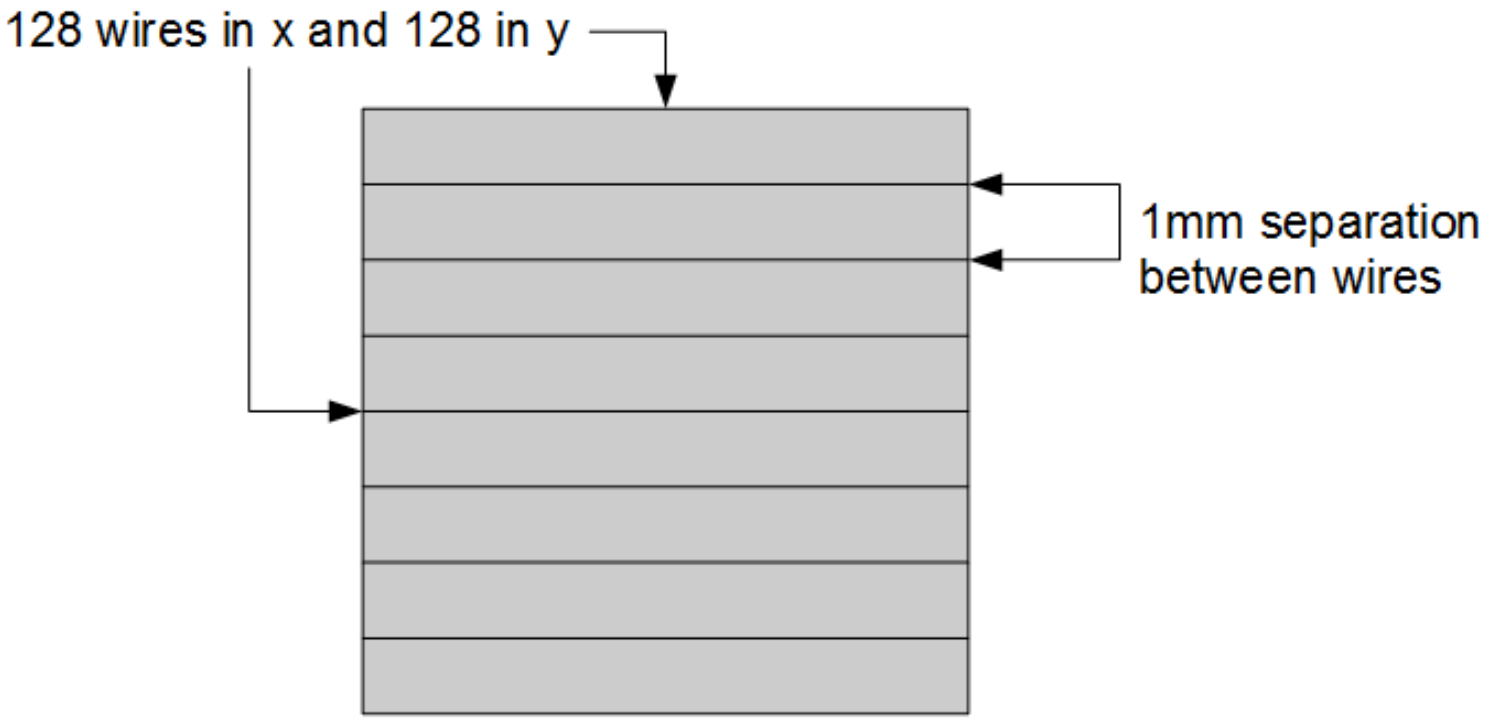
- Overview
- Fixed residual plots
- Angular corrections
- TDC time cut fix
- 2D beam shape plots
- Finding secondary clusters
- Applying downstream ToF corrections and measuring efficiency

Wire Chamber

Wire chambers marked in yellow



What's a wire chamber?

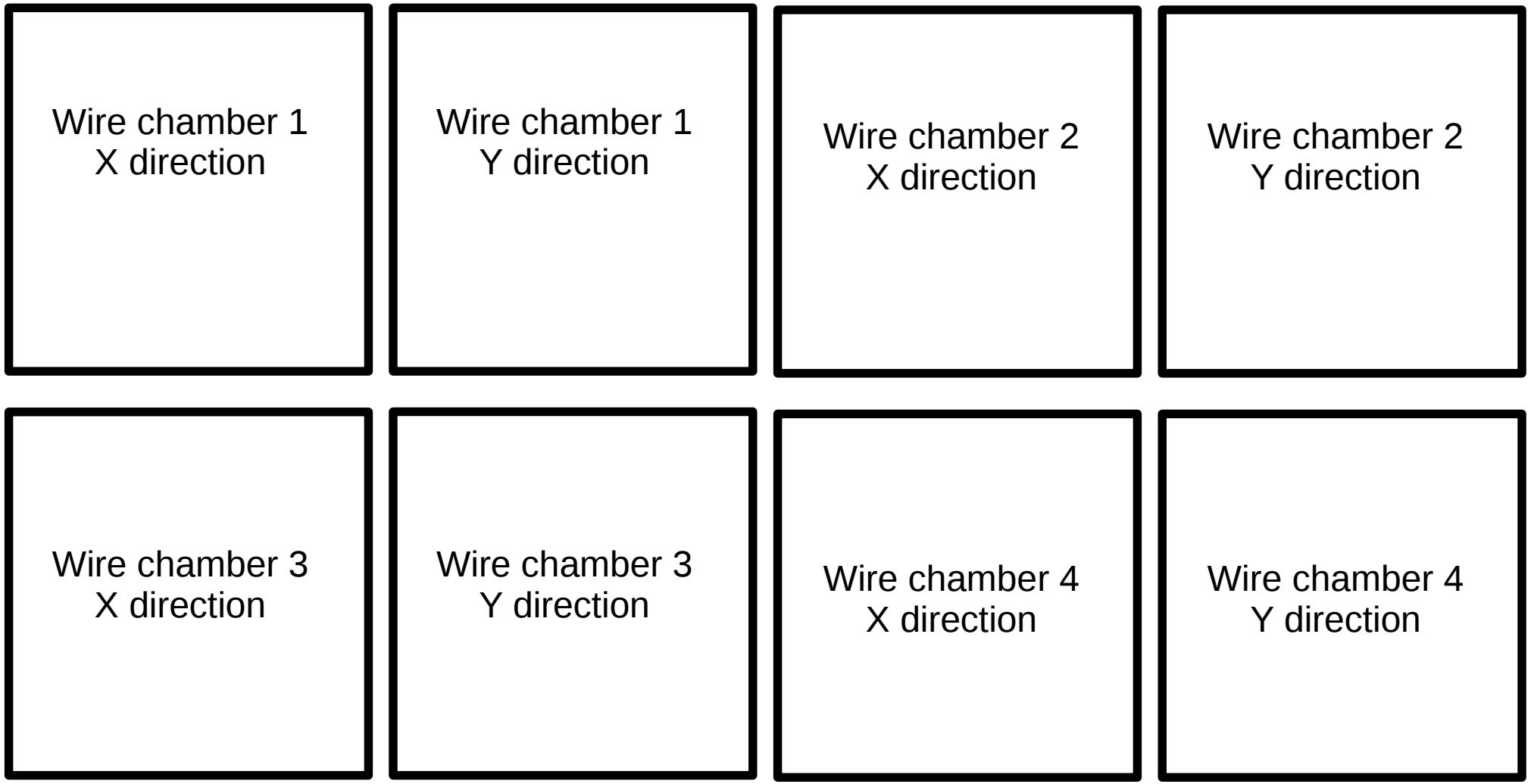


When a charged particle passes through,
the nearest wire(s) register that hit.

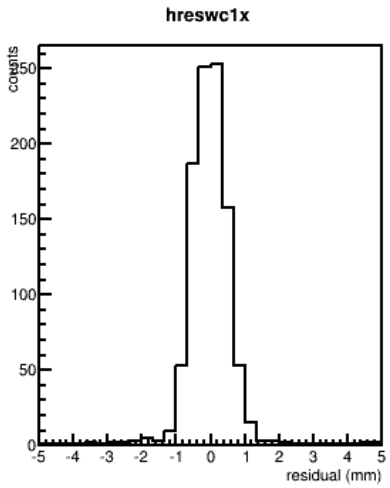
What I did wrong with old residuals

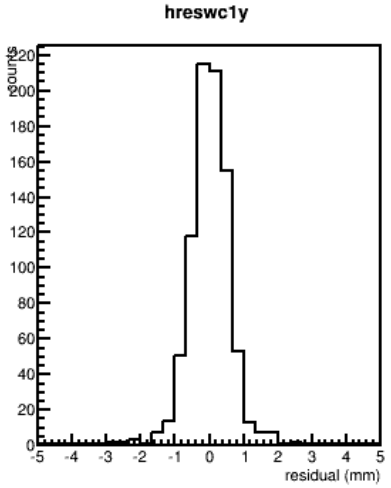
- When creating the tracks for the residual plots, I included the point I was making the residual for
- This introduced a bias into the residual
- For example, wire chamber 4 was a sharp peak
  - This was due to the long lever arm of wc4
    - It's far away from wc1-3

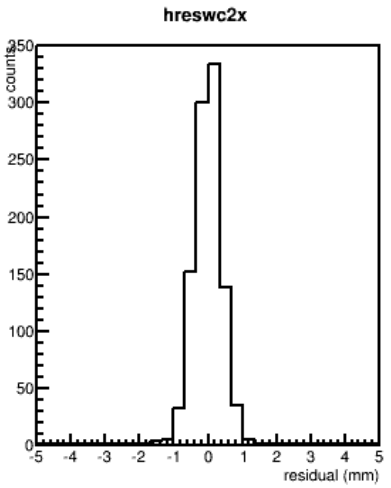
Explanation of 8 plots

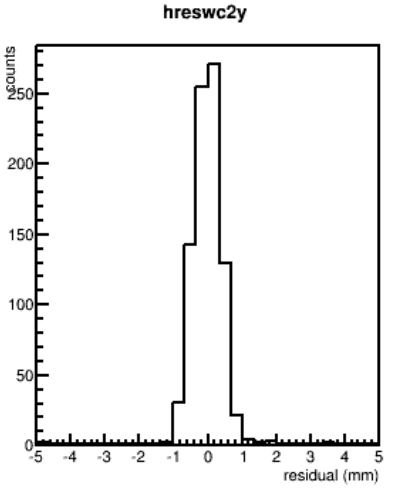


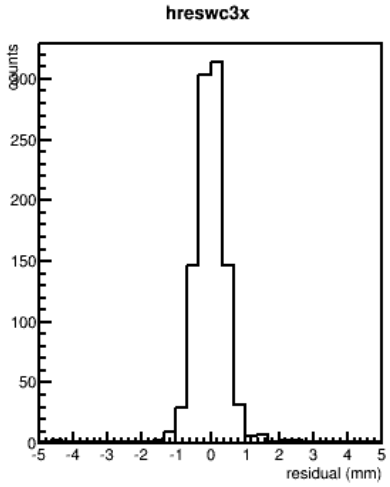
New Residual Plots

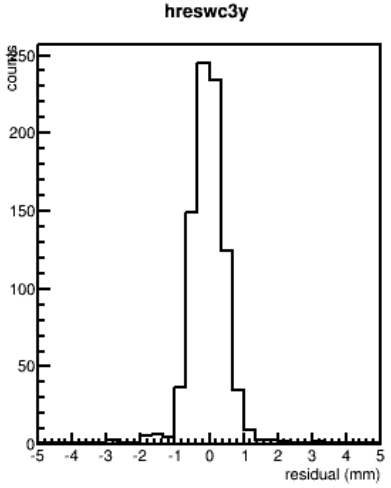


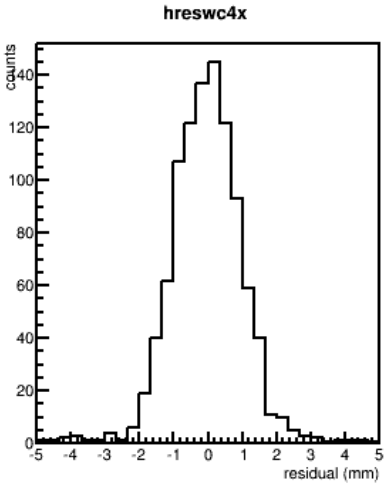


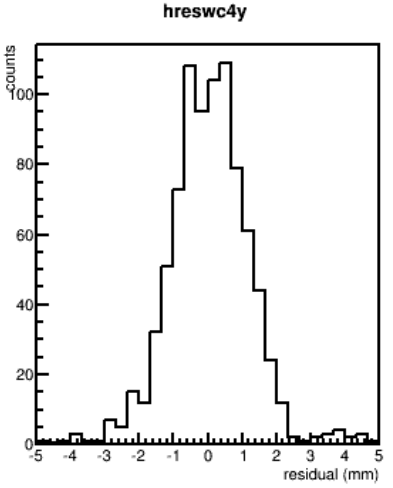






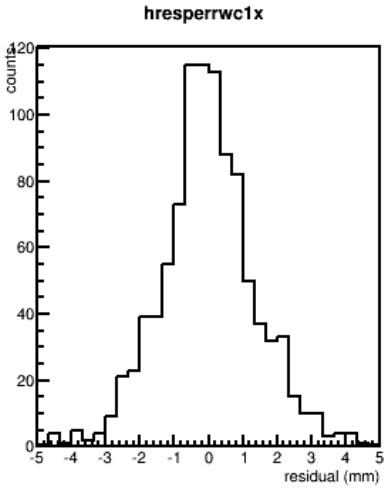


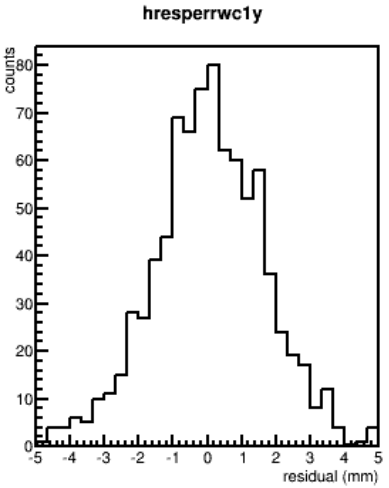


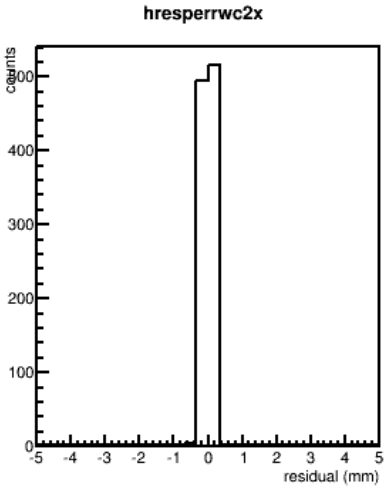


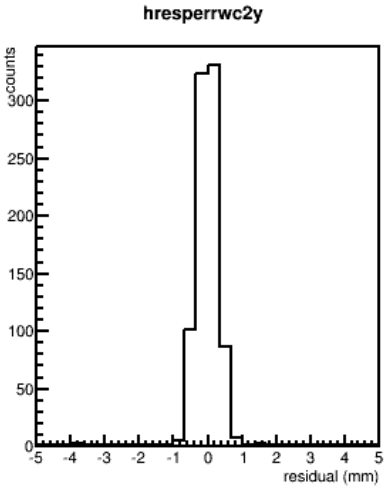
Plotting, cluster position - track-predicted position
Where track is made from 3 other wire chamber clusters
Old residual plots in backup, wc4 had very sharp peak.

New Residual Plots
Residual over error

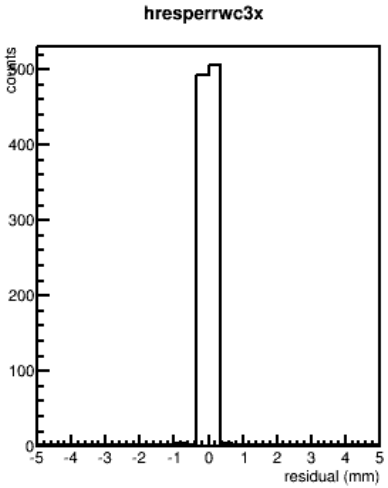


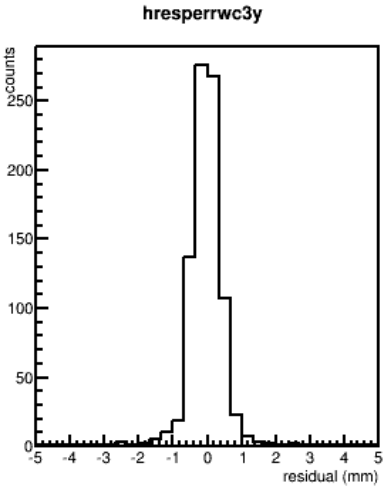


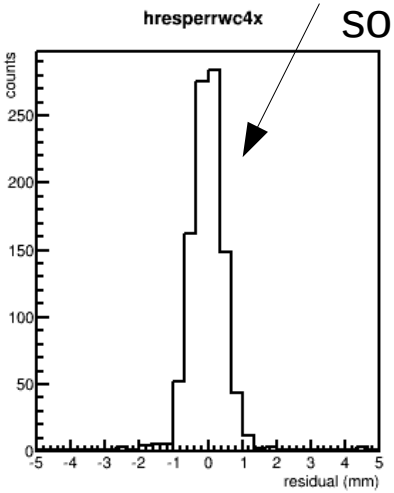


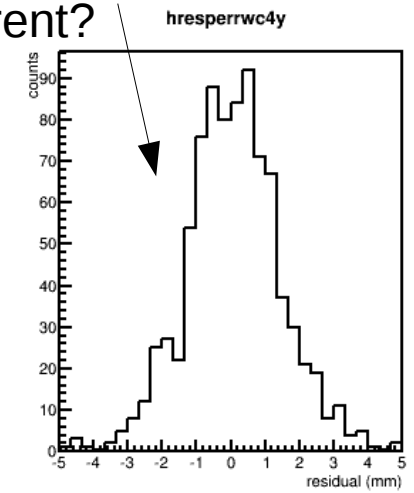


Both WC4:Why so different?



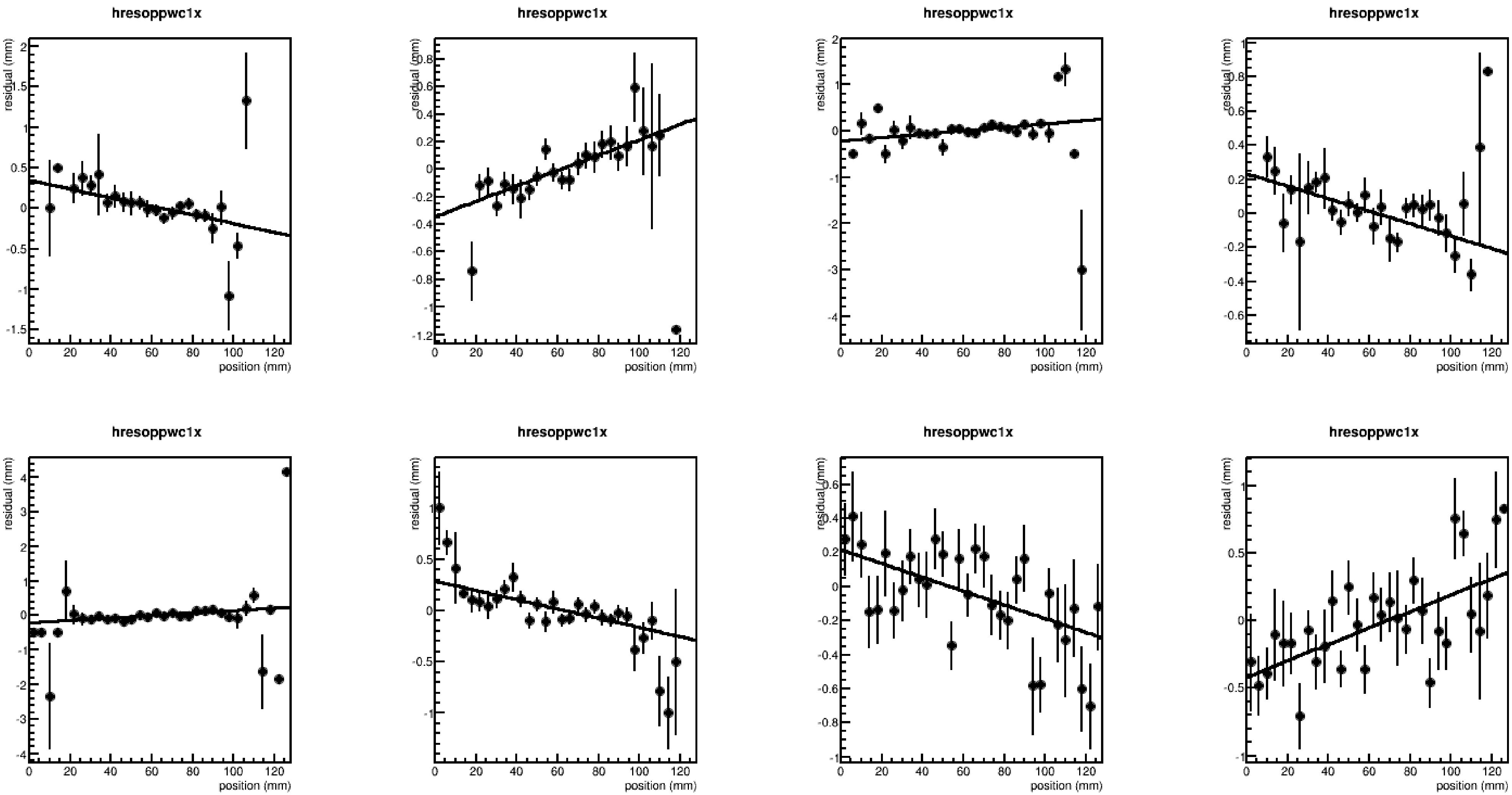






(true – projected prediction) / hit rms

Angular effects, before correction

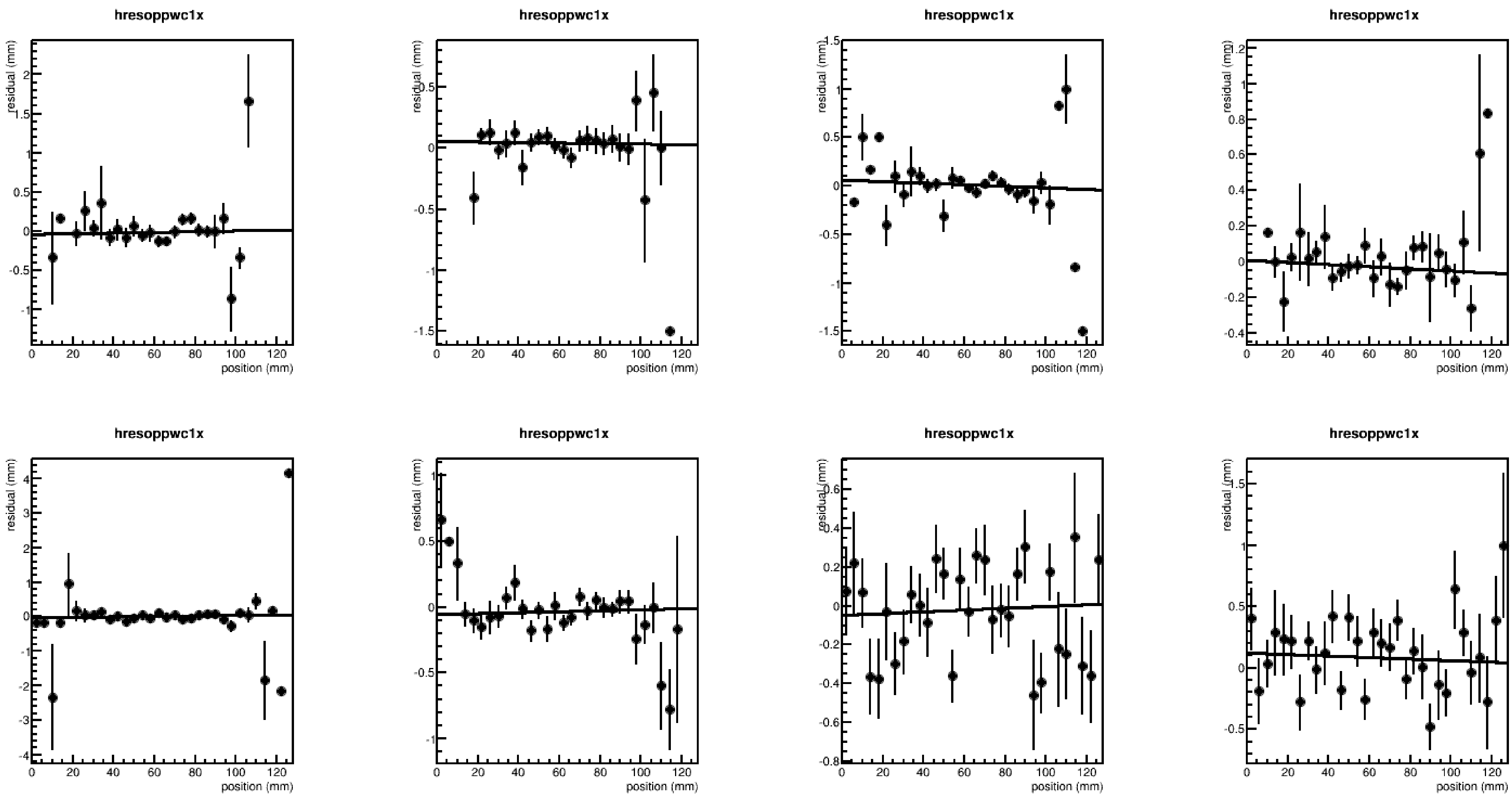


Here I am plotting residual in x as a function of y, and vice versa.
The slope of the line represents that tangent of the angle of the roll of the wire chamber. The largest slope is 0.006 +/- 0.001 for wc4y, slope 0.35 degrees

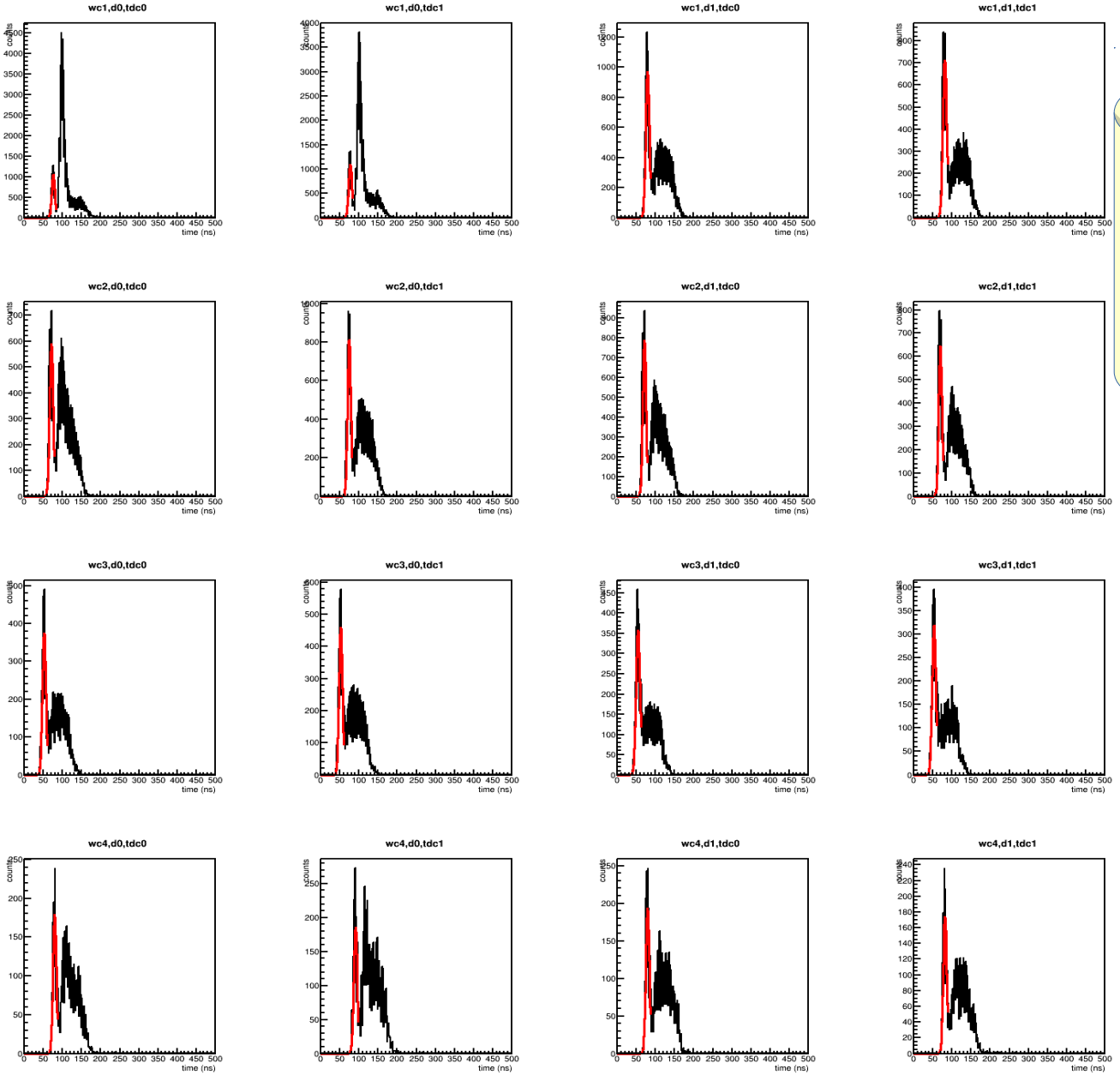
Angular corrections

- dx = m*y+b, and dy = m*x+b
- The error is the fit error propagated to our line,
  - err_x=sqrt(y**2 * dm**2 + m**2 * dy + db**2)
  - (interchange x and y for reverse situation)
- If the 'y' position isn't known then I give a flat error that's the rms of the residual of the vertical axis of the previous slide
  - Basically rms of the residual

Angular effects, after correction



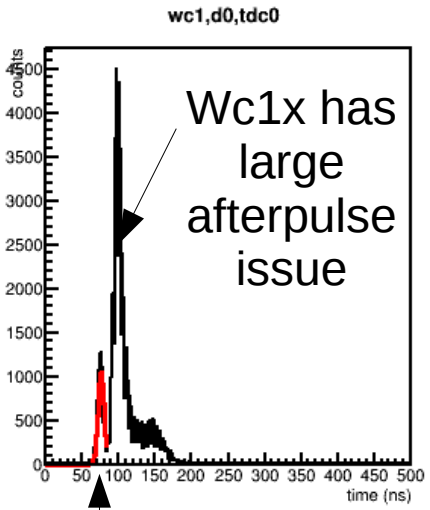
New version of TDC time cuts

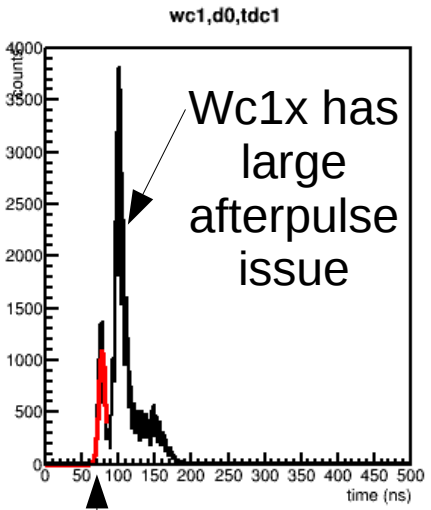


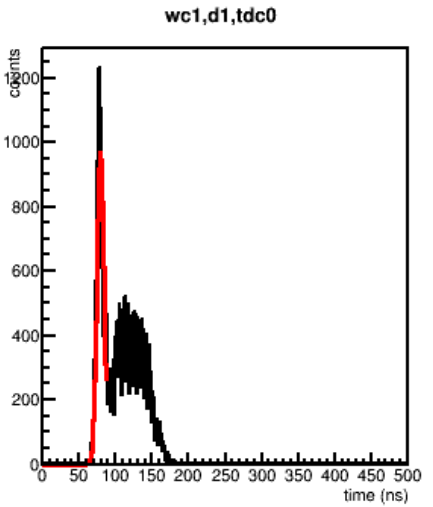
Reminder,
First peak is particles,
Second peak is afterpulse

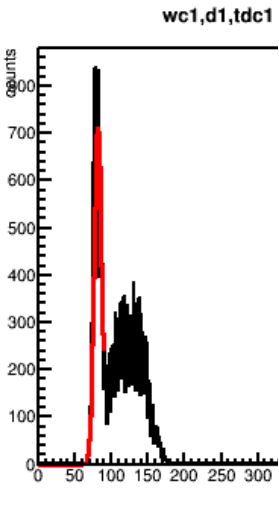
Note the fact that we have more bins and a fix on the high afterpulse peak for wc 1

Next page is zooooomed

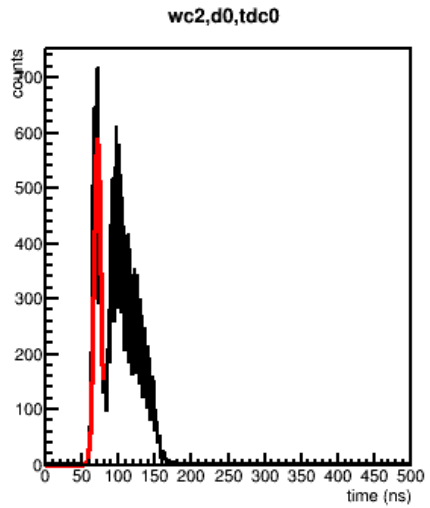


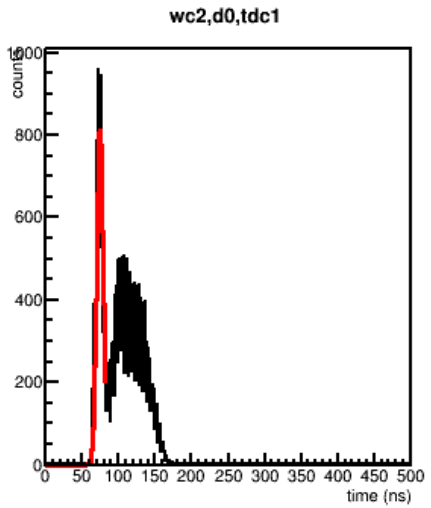


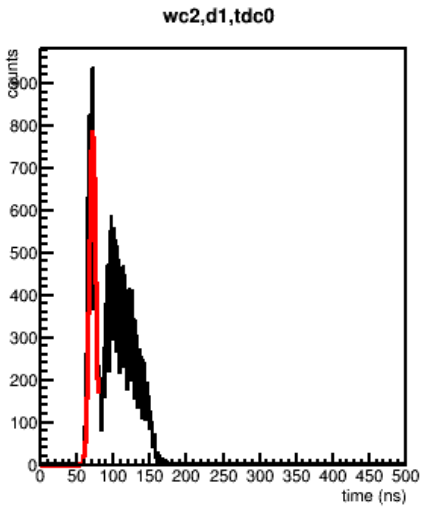


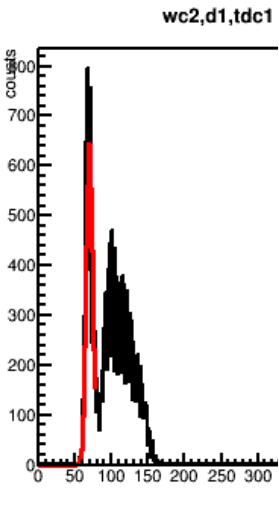


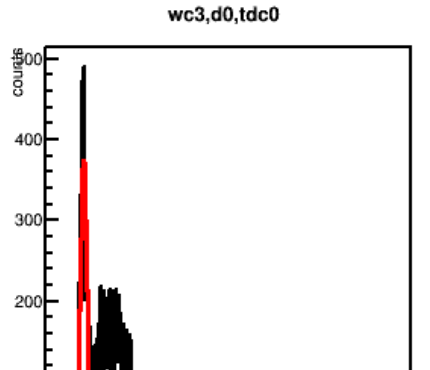
But we fit to the correct peak now

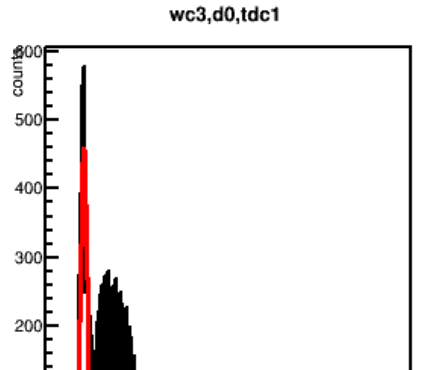


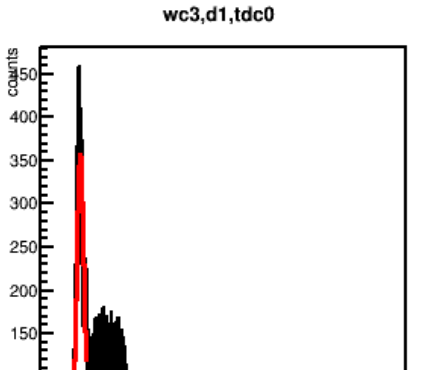


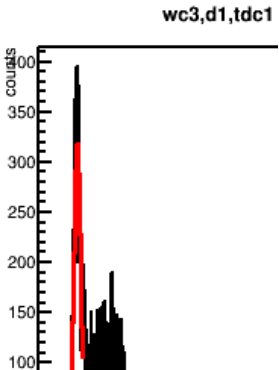




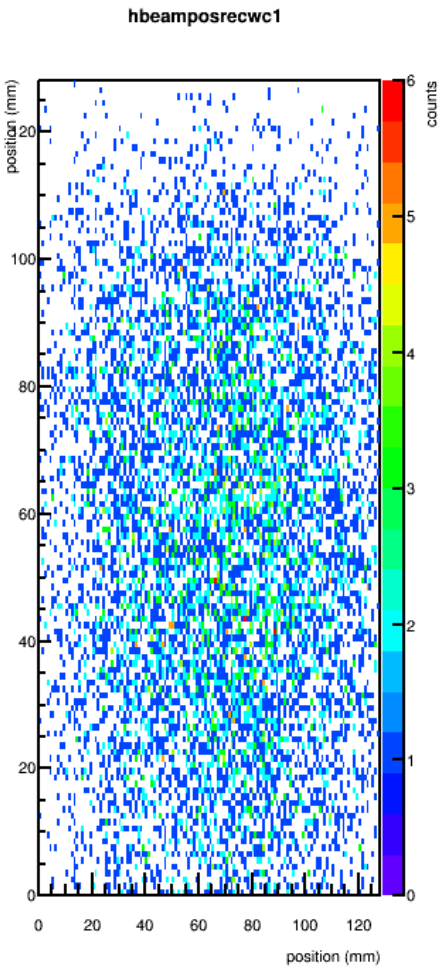


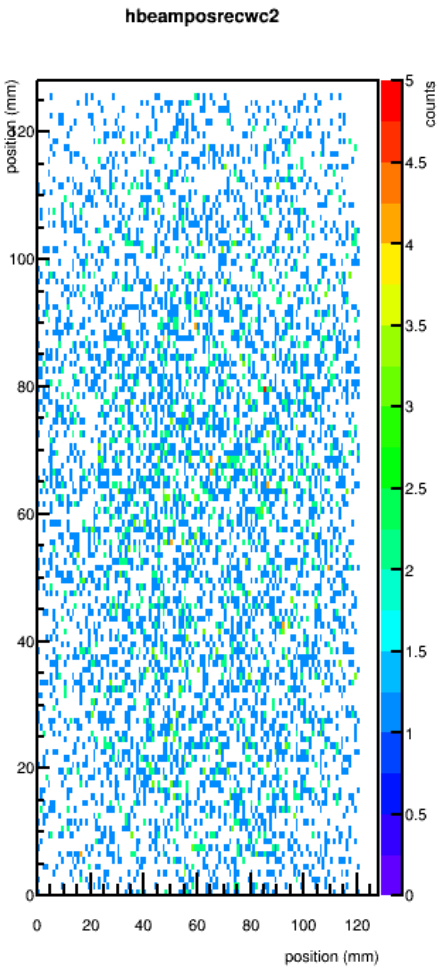


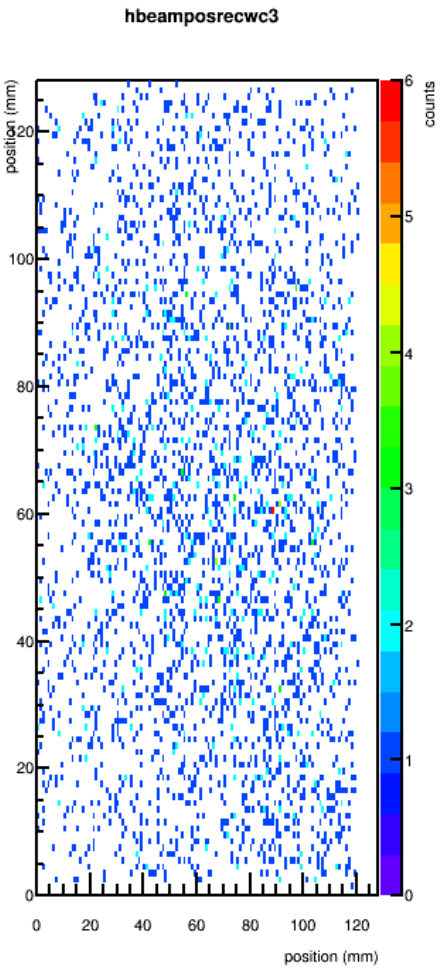


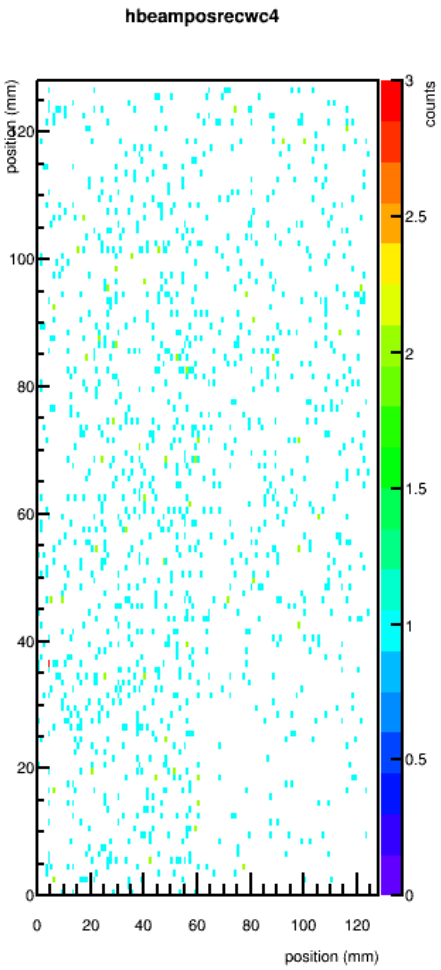


2D plot


hbeamposrecwc1
position (mm)
counts
position (mm)


hbeamposrecwc2
position (mm)
counts
position (mm)

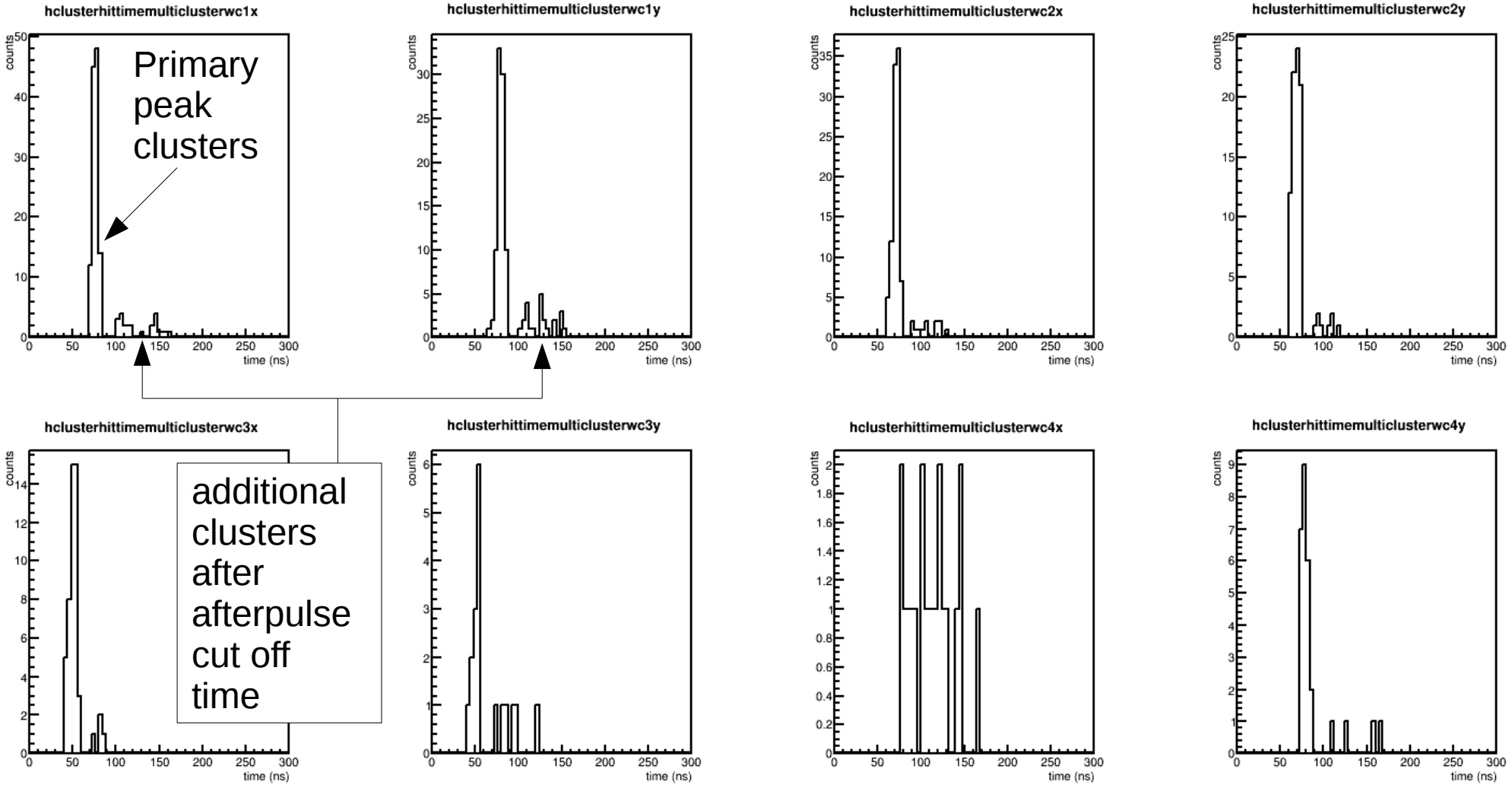

hbeamposrecwc3
position (mm)
counts
position (mm)


hbeamposrecwc4
position (mm)
counts
position (mm)

Finding secondary clusters

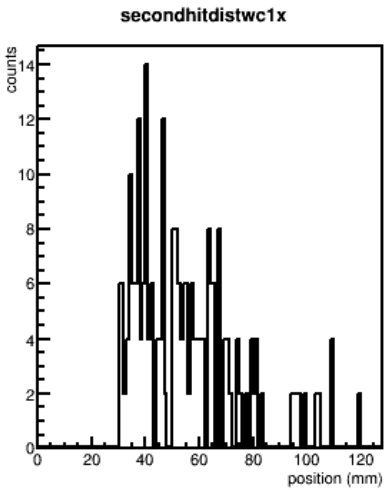
- Finding secondary clusters inside the timecut is evidence that there's a late particle
  - This particle is from a different bin
- Mwpc and cosmic plane is only place to see this extra particle
  - ToF only measures first particle
- My code wasn't originally designed for this

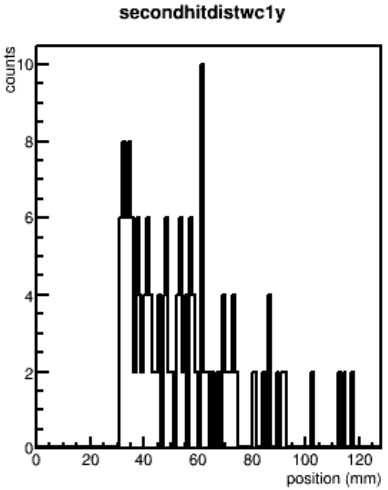
Events with 2+ clusters plotting in time

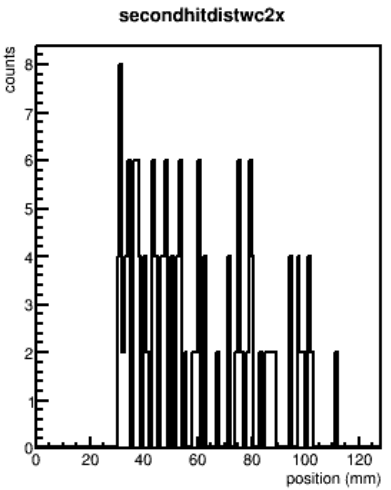


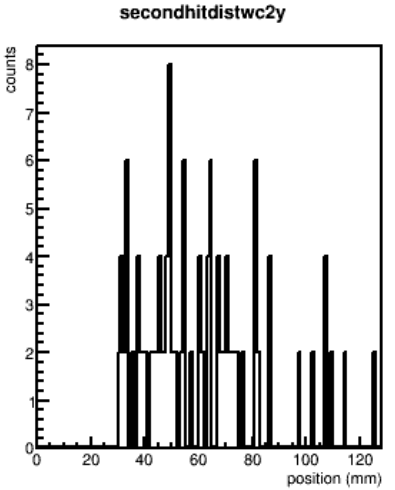
Note: here I set the afterpulse/electron-drift range to 30 wires making it very unlikely that it's either of those (Otherwise we'd just see a smaller version of our afterpulse peak).
We still see particles which might be particles in other bins

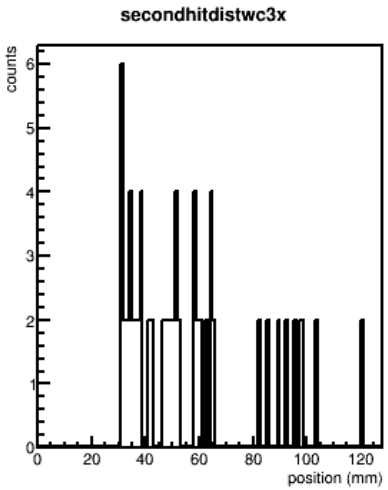
Secondary clusters: Distance from first cluster

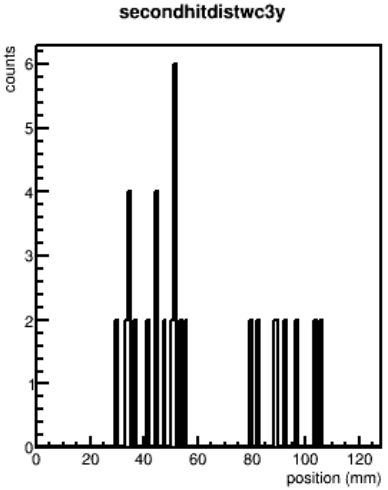


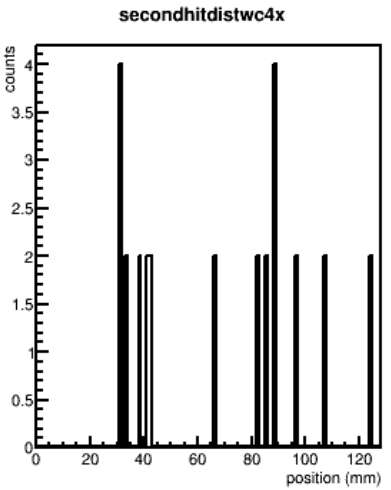


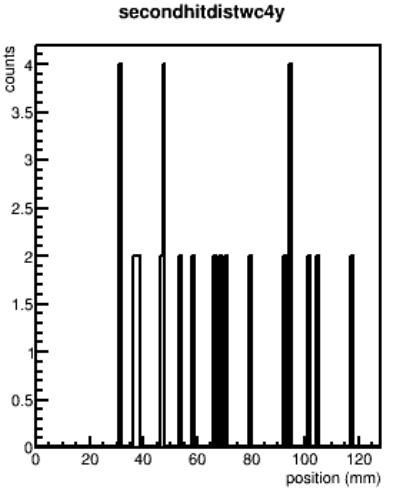






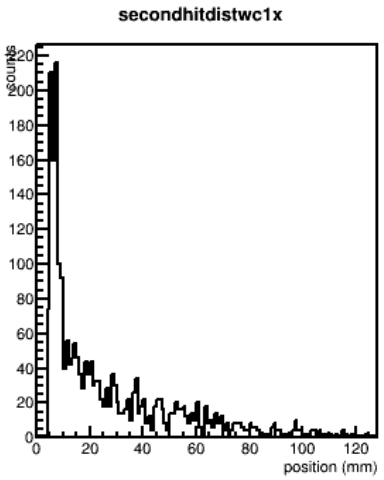


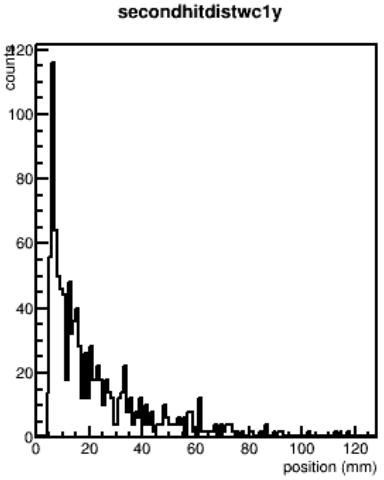


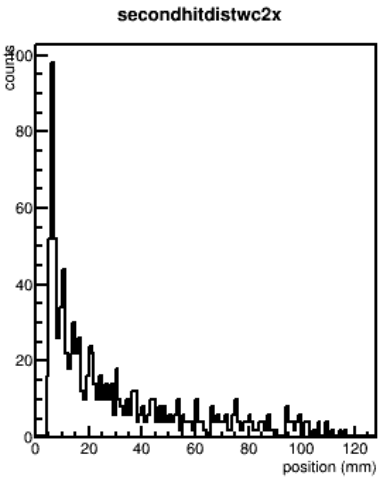


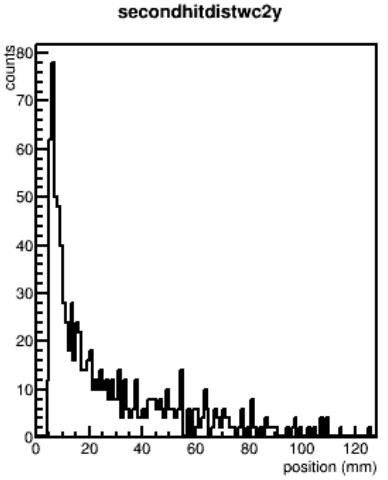
This uses the 30 wire wide afterpulse/electron-drift veto.
See next slide for 5mm afterpulse cut

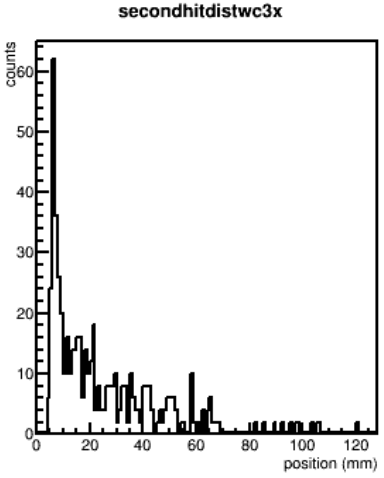
Secondary clusters: Distance from first cluster

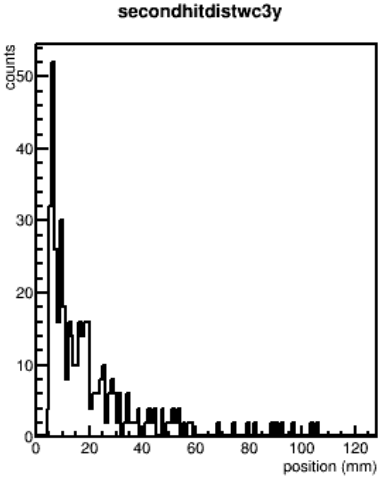


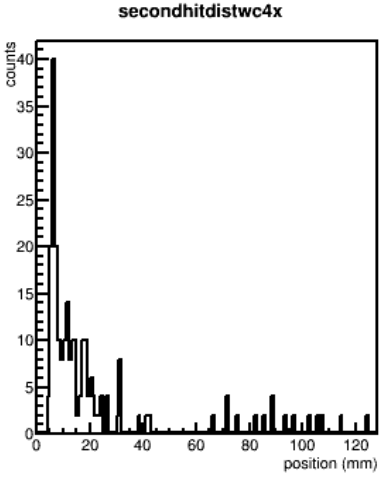


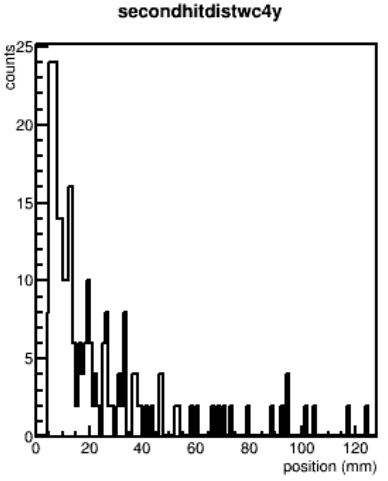












This uses the standard 5mm afterpulse range.
As you can see there are a lot of secondary clusters reconstructed near the first one making me think it's electron drift

Secondary clusters

- They're there
- My code needs fixing/tuning
- Afterpulse cuts should maybe be variable depending on how electron cone evolves

Projecting tracks

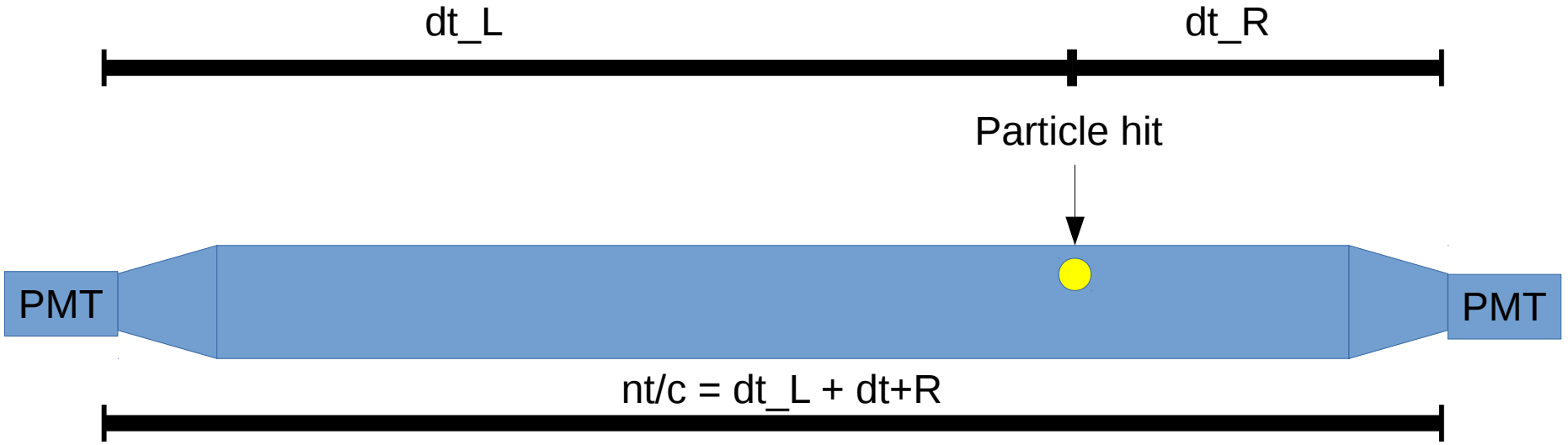
- Tracks are given as m*z+b lines where x=0,y=0,z=0 is top right on wire chamber 1.
- Needed to align the wire chambers with the main detector with muon/high GeV particles
  - Waiting for tracked DSTs (which I'm partly responsible for)
- Included projections to key points in det.

Downstream ToF

- Also can measure efficiency in downstream ToF
- Maybe get better measurement
- I just started thinking about these applications
- Can't do upstream

Downstream ToF

- Right behind wire chamber 4 and before detector – disclaimer: paddle are more square

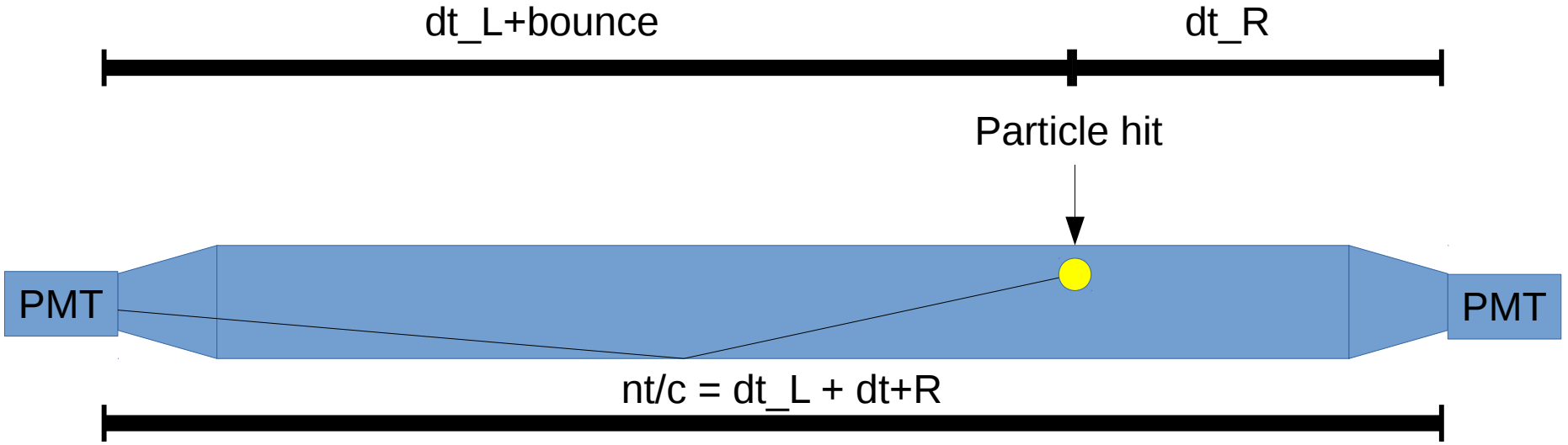


T = (T_L + T_R) / 2
= (2 * travel time + dt_L + dt_R) / 2
= (2 * travel time + nt/c) / 2
= travel time + constant

The sum of dt_L and dt_R is constant (to first order) relative to position.

Downstream ToF

- Can also have light bounce on sides which delays time

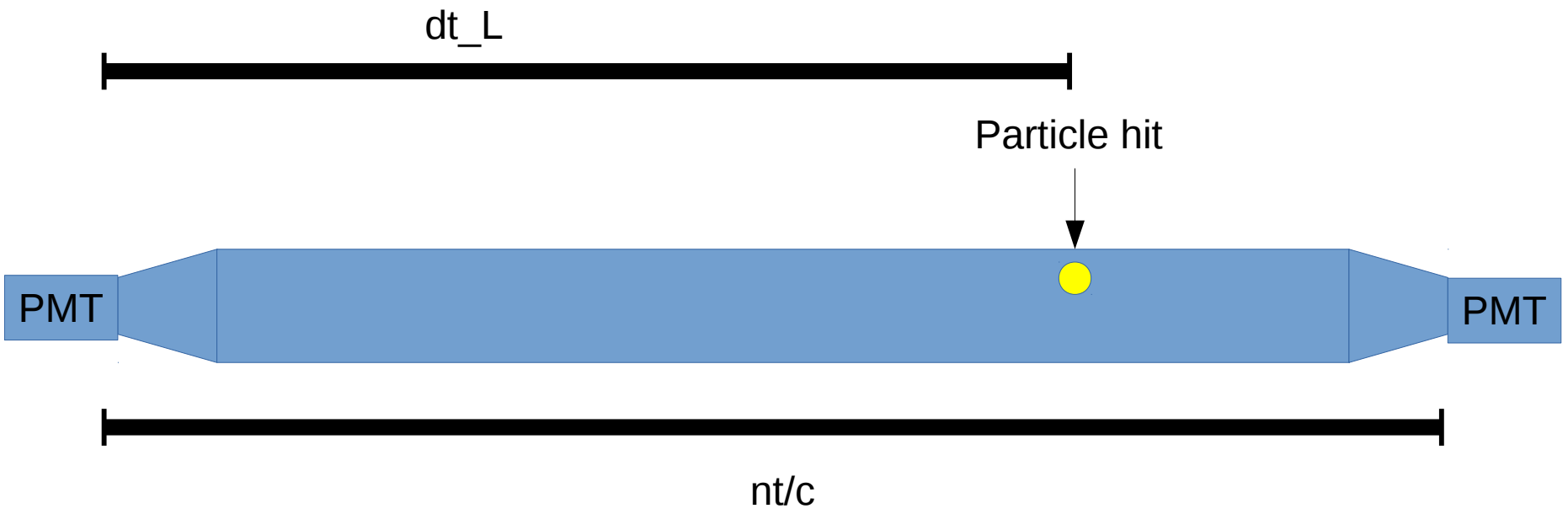


T = (T_L + T_R) / 2
= travel time + constant + bounce/2

Here the reconstructed energy is slightly low. This is a second order effect

Downstream ToF

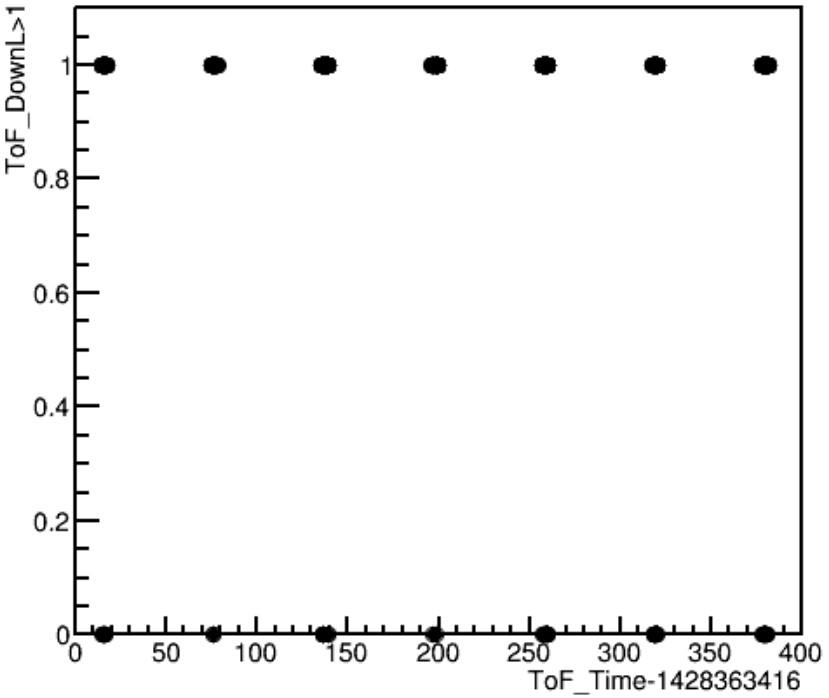
- Here we're missing a right hit
  - So the time is off by dt_L



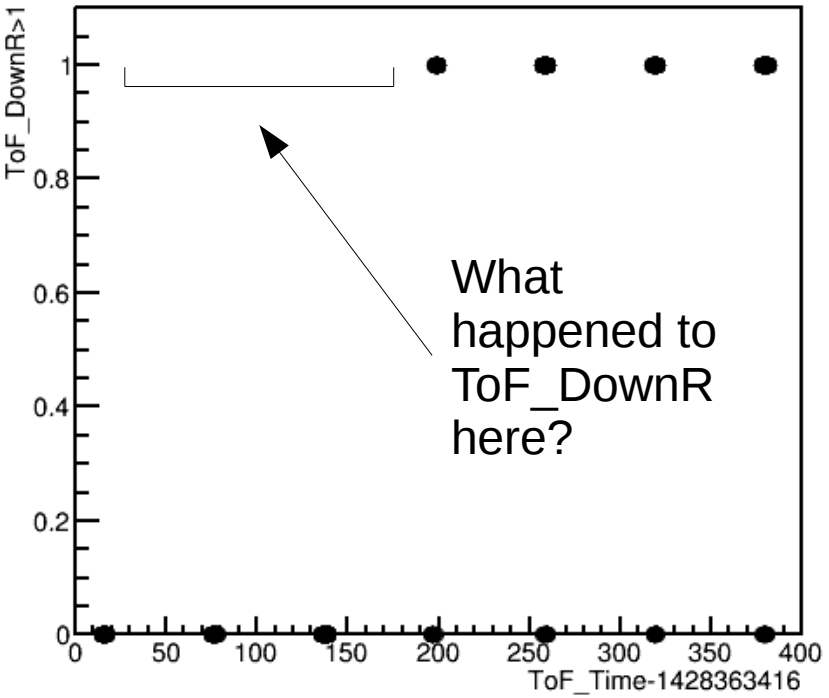
T = travel time + dt_L
Rec energy is lower

Broken downstream

ToF_DownL>1 vs time



ToF_DownR>1 vs time



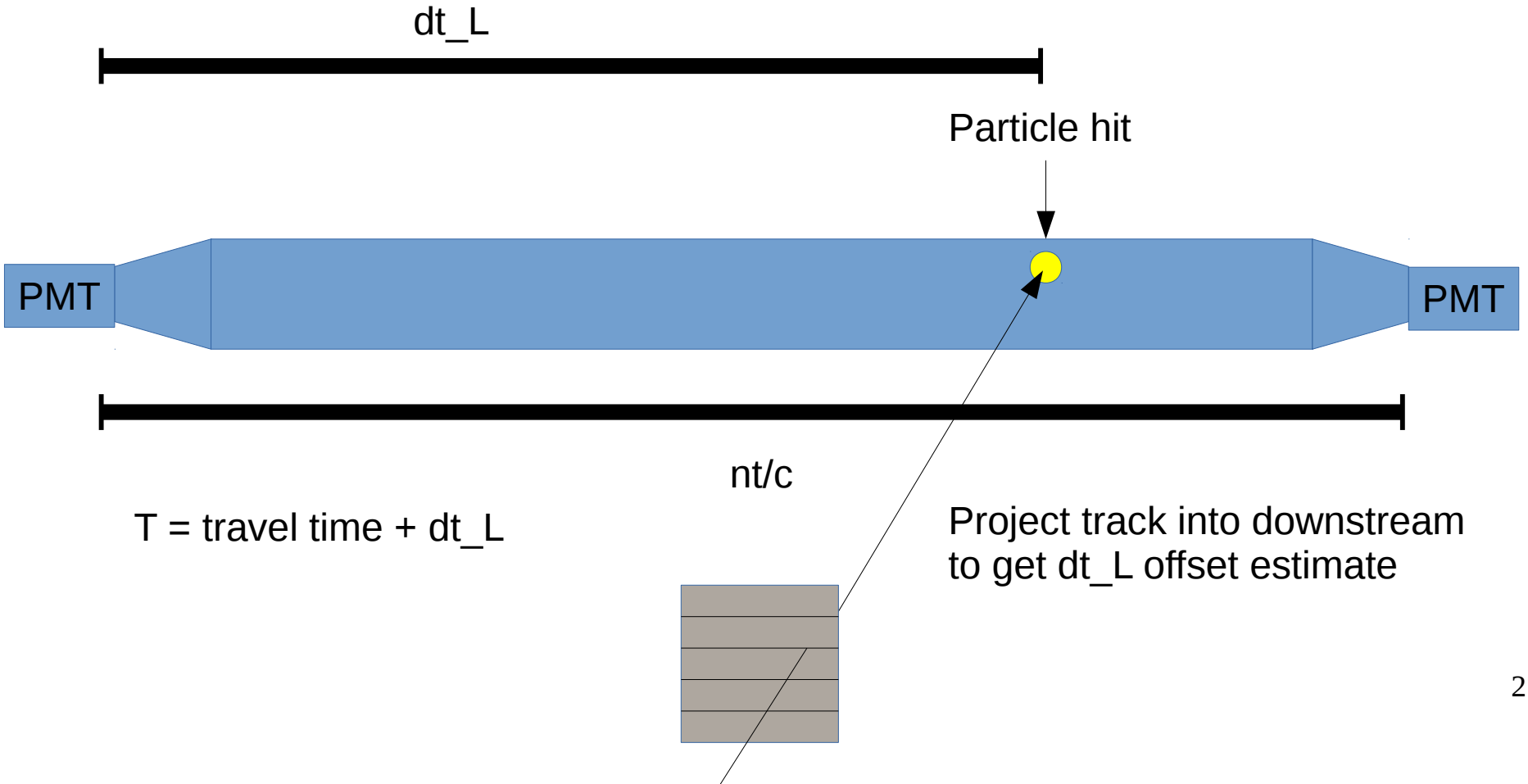
This is 1304/2, 8GeV pos pion.
ToF_DownR is 0 for 1304/1 and the first half of 1304/2.
Rob tells me that the downstream right paddle is unreliable

Tracks

- I'm still working on characterizing tracks
- The projected error into downstream is on the order of 2mm for many tracks
  - But gets worse for others
  - I'm trying to get a handle on this
- I add error when I make my angular correction. Is it increasing my overall error?
  - Not sure yet

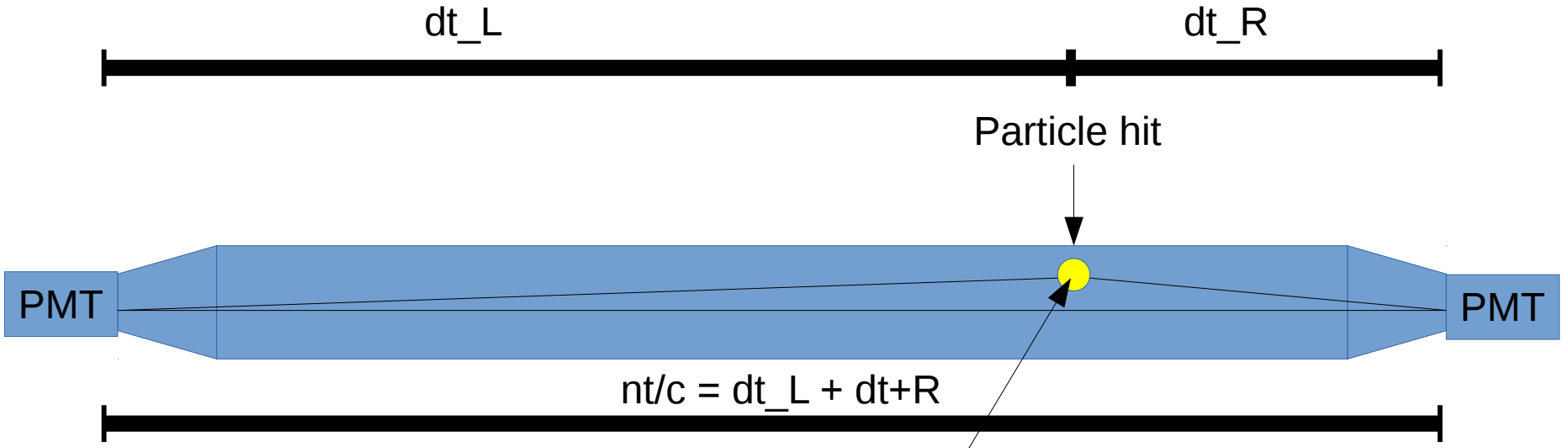
Downstream ToF

- If we know where the particle hits then we can get time back



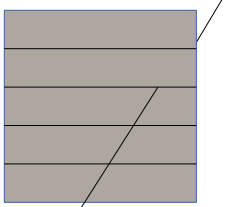
Downstream ToF

- Square paddles mean that light takes longer if it hits above/below the center line



T = travel time + constant + angular effects

The light travels at an angle to the PMTs so there's some delay due to that.
We can reduce those with tracks.



Tracks

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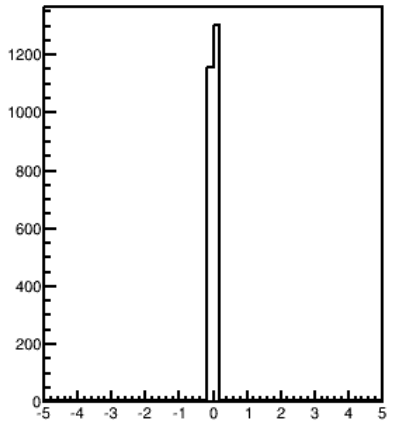
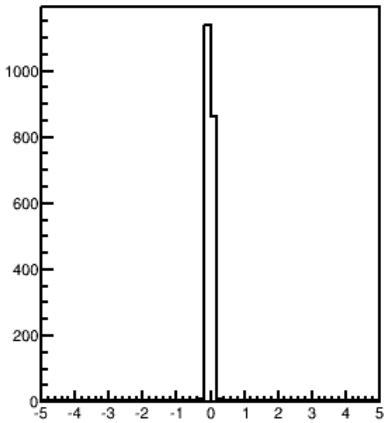
Conclusion

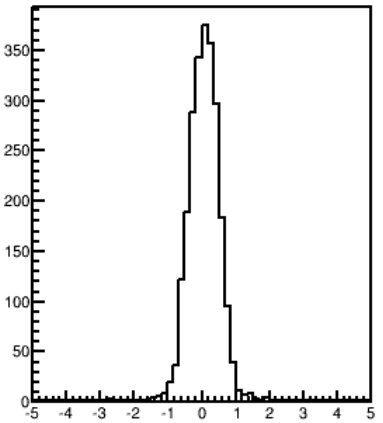
- Mwpc is working
- I'm working on implementing changes
  - But I designed for single hits and throwing away events with secondary events
  - I will rebuild some of my spaghetti code soon

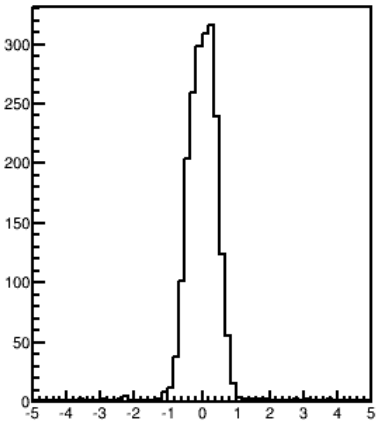
Backup

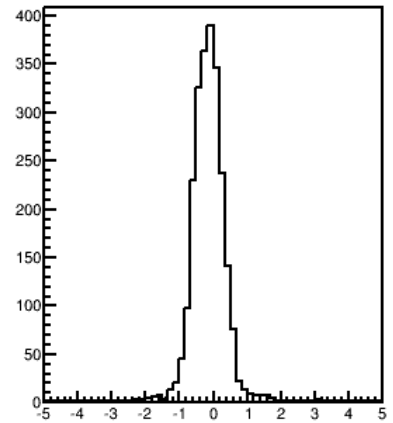
Old Residuals

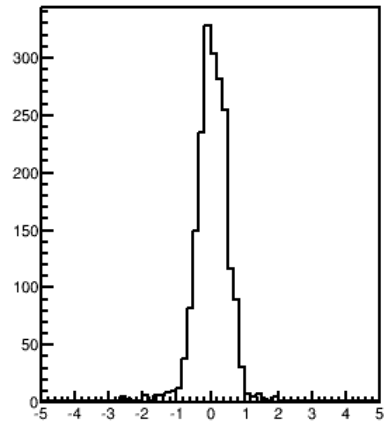


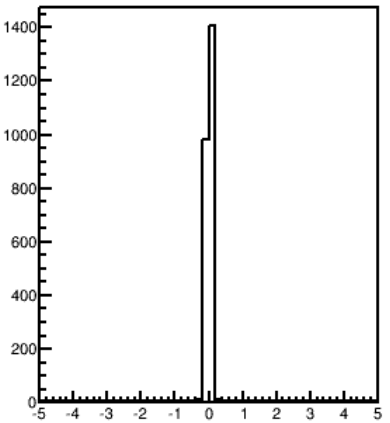


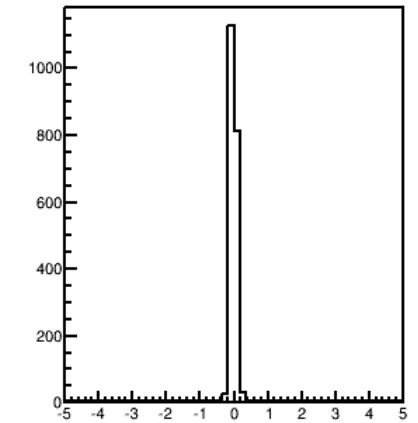




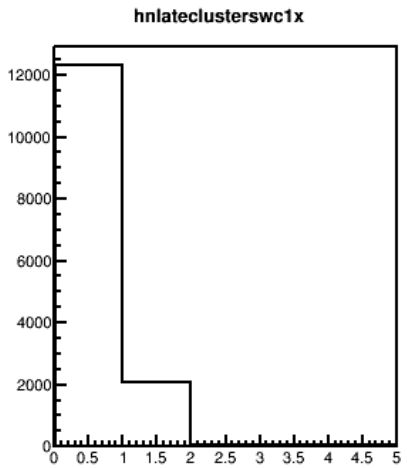


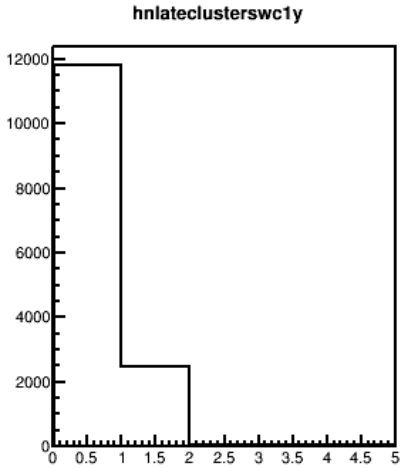


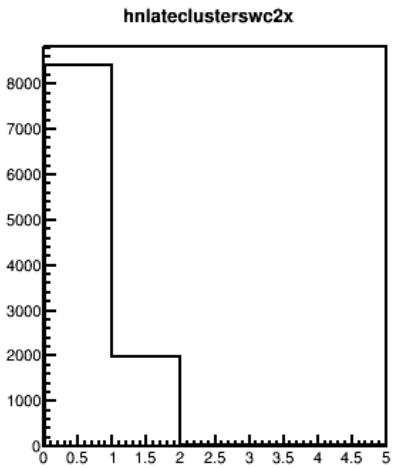


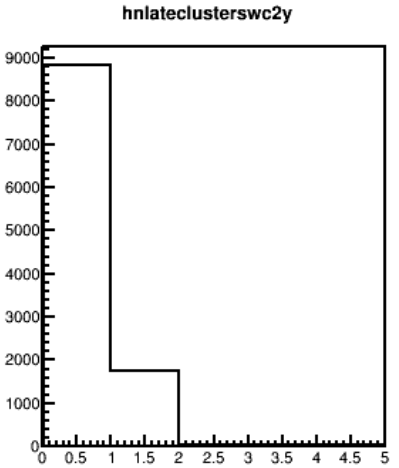


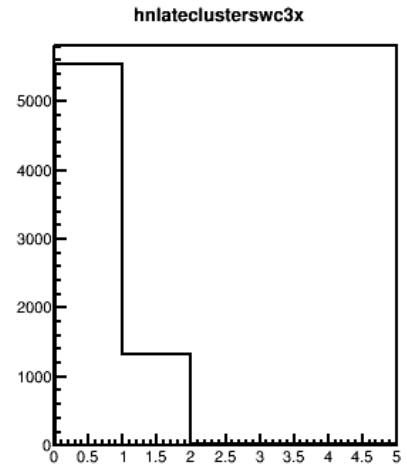
Secondary clusters: Number of late clusters

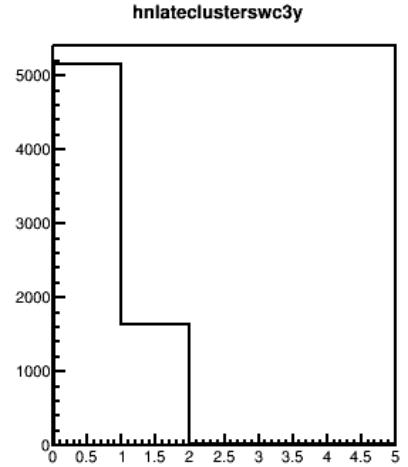


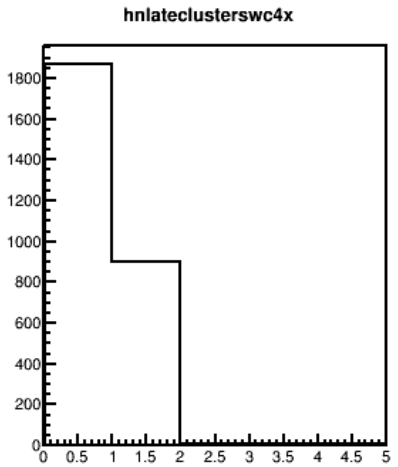


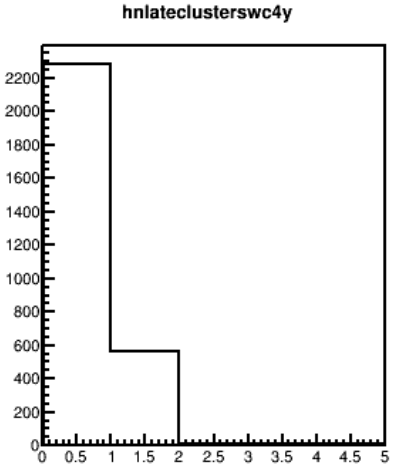












This uses the 30 wire wide afterpulse/electron-drift veto.